

# Professional Development for Secondary School Teachers and Educational Professionals in STEM Fields

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Rural communities are geographically isolated and have limited access to specialized services and ongoing support from content educational experts. As a result, rural school districts across the nation face many challenges related to the recruitment, retention, and professional development for their teachers. Studies have reported that rural school districts experience a shortage of specialized teachers and it is likely that rural school teachers will teach in content areas outside of their area of expertise. Finding mathematics and science teachers is a constant challenge. In response, we developed the Professional Development for Secondary School Teachers and Educational Professionals (PD-STEP) into STEM Fields Model, which utilizes research-based lessons aligned with curriculum standards and purposefully centered on (a) agricultural mathematics, science, and technology knowledge and skills; (b) specific needs of English language learners; and (c) indigenous, authentic agricultural topics through field-based experiences for teachers. The PD-STEP into STEM Fields Model encompasses the development of a lesson plan template and lesson topics that incorporate teachers' professional development training on food, agriculture, natural resources, and human sciences. These professional development activities explore opportunities available in the career paths described by the United States Department of Agriculture and engender resource-rich partnerships among university faculty and rural school teachers.

**Keywords:** rural education, professional development, STEM education

This article is organized in three sections. First, we describe the recruitment of participants from five rural high schools located in South Texas. Second, we present the professional development model and a description of the PD-STEP into STEM Fields Lesson Plans (template and five lesson plans) that incorporate food, agriculture, natural resources, and human sciences (FANH) topics during the first year of the PD-STEP into STEM Fields grant (summer 2018). Third, we present the teachers' perceptions based on their first-year experiences in the PD-

STEP into STEM Fields professional development sessions.

## Rural School District Challenges

Numerous studies have investigated the factors contributing to rural school challenges. Rural students encompass more than 18.7% of the nation's public school enrollment yet receive less federal funding than urban schools (Showalter et al., 2019; Showalter et al., 2017). Documented studies of rural communities verify that rural schools are geographically isolated and experience challenges

in recruiting and hiring specialized content teachers (Hardré, 2011; Monk, 2007). Consequently, rural school teachers may be highly taxed when dealing with classroom situations that require them to teach outside of their content area (Fortney et al., 1999; Hammer et al., 2005; Henry, 2019; Jimmerson, 2004). In addition to geographic isolation, administrators in rural school districts are faced with economic challenges associated with loss of economic bases, lower school district budget revenue, and lack of political capital, leaving school districts with scarce resources to deal with the difficulties of recruiting, hiring, and retaining highly skilled professionals in the areas of mathematics and science (Hammer et al., 2005; Johnson & Zoellner, 2016; McHenry-Sorber, 2019; Monk, 2007; Williams & Grooms, 2016). In spite of these challenges, there are some advantages to teaching in rural school settings including smaller student-to-teacher ratios, which customarily means more time for teachers to individualize instructional time with students (Nagle et al., 2006; Tine, 2017). Smaller classes translate into a reduction in paperwork and record keeping, which gives rural school teachers more time to build stronger, instructionally meaningful relationships with rural students. Establishing meaningful relationships is important because rural schools are the focal points of rural communities (Nagel et al., 2006; Tine, 2017).

Researchers propose that rural school settings can serve as viable contexts for the creation of high-quality learning environments and can play a positive role in increasing student attendance and academic success (Chance & Segura, 2009; Hardré & Reeve, 2003). Some authors have also suggested that the demographics of rural districts are rapidly changing due to an increase in enrollment of English learners (Lauzon & Leahy, 2000; Lichter et al., 2016). Unfortunately, policymakers are not familiar with the academic needs of rural school students and the instructional challenges of rural teachers (Johnson et al., 2014; Lauzon & Leahy, 2000; Lichter et al., 2016). Previous studies emphasized that homegrown teachers familiar with rural students provide place-based-conscious learning and leadership by utilizing the close community relationships and cross-rural school district collaborations typical of

the rural context to positively impact rural school students' academic outcomes (Henry, 2019; Johnson et al., 2009a; Johnson et al. 2009b).

A number of authors have recognized that rural school districts experience challenges in the recruitment and retention of specialized content area teachers—especially mathematics and science teachers (Levin et al., 2011; Monk, 2007). This challenge limits the access of students attending rural school districts to college readiness courses such as calculus, trigonometry, physics, and chemistry as well as curtailing the evaluation and servicing of special needs students (Johnson & Zoellner, 2016; Showalter et al., 2019). Relatedly, funding and justifying the hiring of a specialized teacher is problematic for rural school districts (Howley et al. 2012; Salamon, 2003). In fact, rural school districts prefer to hire teachers certified in multiple content areas like science, mathematics, or social sciences or grow their own teachers (Johnson & Zoellner, 2016). However, this choice is problematic because most rural school teachers need to prepare for multiple courses, and this could potentially lead to teacher burnout. For example, science teachers need to prepare to teach biology, physics, earth science, and chemistry daily (Johnson & Zoellner, 2016). In light of the documented research, rural school district leaders must appreciate the important role played by resource-rich partnerships that increase the content-based capacity and professional development training of rural school teachers (Henry, 2019).

### **Rural School Teacher Challenges**

Rural school teachers play a critical role in motivating secondary students to pursue postsecondary education. Unfortunately, isolation from content-specific colleagues and lower salaries make rural school districts less attractive to cross-certified teachers (Johnson & Zoellner, 2016). Nevertheless, cross-certified teachers are highly sought after by rural school districts and are a challenge to find, hire, and retain (Johnson & Zoellner, 2016; Tine, 2017). In the rural school context, and given the challenges that rural school districts face in finding mathematics and science specialized teachers, teachers have multiple class

preparations for various grade levels (Rhodes, 2014). According to Burt and Boyd (2015) the “ideal rural teacher is someone who is comfortable with the rural way of life and capable of wearing many hats” (p. 78); in other words, the rural teacher needs to be certified to teach multiple subjects or grade levels, prepared to supervise several extracurricular activities, and able to teach students of differing ability levels within a single classroom. Based on our review of the literature pertaining to the multifaceted demands experienced by secondary school rural school teachers, we applied for and were awarded the Professional Development for Secondary School Teachers and Educational Professionals (PD-STEP) in Science, Technology, Engineering and Mathematics (STEM) Fields grant to support five rural school districts by providing professional development that utilized research-based instructional lessons aligned and centered on agricultural mathematics, science, and technology knowledge and skills.

### **The PD-STEP into the STEM Field Model and Objectives**

In 2018, the National Institute of Food and Agriculture of the U.S. Department of Agriculture awarded the PD-STEP into the STEM Fields (PD-STEP) Professional Development grant to a regional university in South Texas. The goal of PD-STEP was to develop rural high school teacher teams (STEM Field Teams) in mathematics, science, career, and technical education to implement an innovative, agricultural-based, hybrid professional development model to address both the Agriculture and Food Research Initiatives and the Education and Literacy Initiatives and make the services of these STEM Field Teams available to five rural school districts. The overarching goal of the PD-STEP Professional Development Grant was to identify, utilize, replicate, and disseminate instructional research-based best practices in an agricultural real-world context.

PD-STEP utilized research-based instructional lessons aligned to the curriculum standards prescribed by the Texas Education Agency (2020b)—known as the Texas Essential Knowledge and Skills (TEKS) standards—purposefully centered on field-based experiences in

(a) agricultural mathematics, science, and technology knowledge and skills; (b) specific needs of English language learners; and (c) indigenous, authentic agricultural topics. In addition, based on the advice of the Agriculture & Food Research Initiative, PD-STEP focused on key problems of local importance that impact regional, national, and global sustainability of organic and urban agricultural systems such as:

- farm efficiency
- profitability
- sustainability
- ranchery
- bioenergy
- rural ecology
- aquaculture
- near communities
- human nutrition (National Institute of Food and Agriculture, 2021).

### **Recruitment Activities Summer 2018 (Year 1)**

According to the National Center for Education Statistics (2013), Texas is characterized as having the largest rural student population in the nation (Johnson et al., 2014) with 459 rural school districts (Texas Education Agency, 2017). Texas Education Commissioner Morath launched the Texas Rural Schools Task Force in 2017 to bring rural school superintendents together to discuss the educational challenges faced by rural schools.

The authors of this article were the members of the PD-STEP project team. We carefully planned on-site visits to each of five Texas rural school districts. The school districts were identified, in large part, from the Texas Education Agency’s Texas Academic Performance Reports (2020a) that indicated a low level of participation in Advanced Course/Dual Credit Completion, as well as their proximity to the university. The five school districts are located within an 85-mile radius, rendering the university the only four-year college readily accessible to these rural school districts. We anticipated that the students of the teachers participating in this project would also have access to faculty at the university, potentially encouraging students to consider attending college after graduation. We also anticipated that the

participating students and teachers would collaborate closely with faculty and staff at the university. Our community outreach efforts aligned with the goal of the university to create a transdisciplinary and collaborative research environment to foster discovery and prepare a community of critical thinkers for leadership roles. Prior to submitting the PD-STEP grant proposal, the Principal Investigator (Viloria) scheduled face-to-face meetings with the superintendents of each of the five school districts to secure their support for the participation of mathematics, science, and career and technology high school teachers in the professional development sessions over the three years of the grant. The PI and a CoPI travelled to each of the school districts to deliver teacher applications and meet with district representatives. The fifteen participating teachers' demographic information and some details of the schools and districts are shown in Table 1. The teacher recruitment process took three months (April through June). With the support of the district superintendents and the principals of the respective high schools, 15 secondary teachers came on board, three from each of the participating school

districts (see Table 1). According to the PD-STEP eligibility criteria, teachers were eligible to participate if they

- (a) had fewer than five years of teaching experience (preferred but not required);
- (b) were in a STEM field or seeking STEM field certification;
- (c) were bicultural, bilingual, and/or biliterate (preferred but not required); and
- (d) had prior experience in an agricultural area (preferred but not required).

It was challenging to convince some teachers to commit to a week-long summer professional development session. Due to the distance from their homes, we provided the option for participants to live on campus. Only five teachers opted to accept this offer while the rest used a district vehicle to commute daily. Table 2 shows the academic disciplines represented by the first-year PD-STEP rural school teachers.

**Table 1**

*District Details and Teachers' Demographics*

School District	Number of Teachers	Number of Schools	Community Population	Number of Teachers Selected	Participants' Demographics
Cotulla ISD	110	5	4,137	3	1 White female 1 Hispanic female 1 Hispanic male
Freer ISD	60	3	2,666	3	1 White male 1 Hispanic male 1 Hispanic female
Jim Hogg ISD	86	3	4,558	3	1 Hispanic male 2 Hispanic females
Webb County ISD	26	3	Bruni: 379 Oilton: 152	3	3 Hispanic males
Zapata ISD	227	6	14,179	3	2 Hispanic females 1 Hispanic male

*Notes.* Data from Texas Education Agency for 2018–2019 (2017, 2018–2019, 2020a) and U.S. Census, 2019. “ISD” is an abbreviation for “independent school district.”

**Table 2**

*Academic Disciplines Among the PD-STEP Teachers*

<b>Agricultural Science</b>	<b>Family &amp; Consumer Science</b>	<b>Algebra 1, Computer Science, English 3 &amp; 4</b>	<b>General Science</b>	<b>Biology, Pre-AP Biology</b>	<b>Chemistry &amp; Environmental Science</b>	<b>Algebra 2, Pre-AP Algebra 2</b>
1	1	1	2	3	2	5

**The First Year PD-STEP Professional Development Activities**

As previously mentioned, studies have found that rural school teacher professional development and training and support are important (Burt & Boyd, 2015; Johnson & Zoellner, 2016; Rhodes, 2014; Tine 2017). For the first year, the PD-STEP team focused, among other things, on garden-based learning (Desmond et al., 2004; Williams & Dixon, 2013) and field-based experiences that were conducted at a local ranch. As Williams and Dixon (2013) pointed out, garden-based education tends to be multidisciplinary, so the PD-STEP team used this idea to provide PD-STEP teachers with agricultural mathematics, science, and technology knowledge and skills via hands-on professional development. Furthermore, the PD-STEP lessons incorporated the specific needs of English language learners and the hands-on lessons served as the canvas on which to integrate multidisciplinary activities and active learning.

Garden-based education activities took place in different ways. The PD-STEP team partnered with the Texas A&M University Agrilife Extension Center, whose representatives presented the Learn, Grow, Eat, & Grow curriculum overview. The participating teachers received training in how to set up garden beds and were offered predesigned lesson plans from the 4-H curriculum that discussed topics such as pollination, nutrition, and growing rates. Teachers also observed a cooking demonstration that incorporated healthy eating habits and integrated topics in biology, chemistry, and algebra. The curriculum was intended to be modified by the teachers to cater for their students’ needs, academic level, and age group. Another activity was a visit to the Laredo Center for Urban Agriculture

and Sustainability that houses one of the major community gardens in the city. In addition, a Master Gardener shared best practices for developing and maintaining a school garden.

At the end of the week, through collaboration with the agriculture-related community, the PD-STEP teachers visited the East Foundation Ranch. During this visit, teachers explored authentic agricultural topics through field-based experiences at the ranch. For instance, they discussed structure/function and survival, biotic and abiotic ecosystems, and groundwater, surface water, and watersheds. Throughout the week, teachers attended multiple demonstrations of hands-on activities that incorporated agricultural mathematics, science, and technology knowledge and skills topics.

**PD-STEP Lesson Plans**

At the forefront of PD-STEP is the implementation of lessons with field-based experiences, situated learning (Korthagen, 2010), experiential methods (Steffe et al., 2000), and problem-based learning (Savery & Duffy, 1995) in the agricultural environment. A number of authors have recognized that effective lesson plans incorporate relevant, research-based, instructional best practices like cooperative learning (Johnson et al., 1994), culturally relevant pedagogies (Nieto, 2013), the Technical Language Acquisition and Retention Model (Mireles et al., 2019), the jigsaw strategy (Slavin, 1984), reciprocal teaching (Palinscar & Brown, 1984), and the 5E instructional model (Bybee, 2015). Typically, the model lessons begin in the classroom and then students are taken to the field to observe a real-life manifestation of the lesson (Mireles, 2017). This design innovatively inverts this curricular flow, resulting in authentic,

real-life experiences that anchor conceptual understanding in a contextual fashion (Mireles, 2017). Another unique aspect of the proposed lessons involves incorporating the mathematics and science correlation model (Offer & Mireles, 2009) as well as adaptations for English language learners (Casey et al., 2018).

We developed pathways to identify and replicate best practices to engage youth in STEM within FANH through the PD-STEP professional development activities. We initiated the development of the PD-STEP Lesson Plan template and shared the first four STEM Field lessons, which were to be explained during the professional development session. These initial lesson plans were designed to be consistent with the STEM Field Model. For example, the PD-STEP topics in the lesson plans included “Beautiful Patterns.” The “Beautiful Patterns” lesson is based on the Fibonacci sequence and how the shape of many naturally occurring biological organisms conforms with graphical representations of the Fibonacci sequence and its close relative, the golden ratio (Nematollahi et al., 2020). In this lesson, students are engaged in activities that include measuring the golden ratio relative to a given row-length of vegetables with at least 80% accuracy when growing their own plants. They then relate their findings to the golden ratio of the Fibonacci sequence and discuss how growth patterns in nature conform to graphical representations of algebraic, linear, quadratic, and exponential expressions. These topics align closely with TEKS as well as Next Generation Science Standards (2013).

### **PD-STEP Teachers’ Activities**

Each of the 15 teachers was asked to develop three STEM Field lesson plans and the lessons were uploaded to the PD-STEP digital repository. Over the first year, in addition to the four lessons developed by the PD-STEP team, 40 lessons were developed by the participating teachers. We anticipate uploading a further 45 lesson plans each year of the grant so that there will be a total of 109 lesson plans at the end of this grant. The PD-STEP digital repository can be accessed at <https://www.tamtu.edu/coedu/pdstep.shtml#lesson>

. After the professional development week and through the end of the first year, all the teachers completed three individual agricultural STEM lesson plans. All lesson plans in the repository will be shared with participating school districts and school districts nationwide at the conclusion of the PD-STEP grant.

Finally, since one of the aims of the PD-STEP project was to provide agricultural math- and science-based experiential learning opportunities, teachers were also able to use the remainder of the school year (2018) to access the online Texas A&M Master Gardner training modules and continue to volunteer for a total of 50 hours of hands-on work related to agricultural STEM activities in their immediate communities.

### **Documenting PD-STEP Teacher Experiences**

According to Burt and Boyd (2015), the ideal rural teacher is someone who is comfortable with the rural way of life and capable of wearing many hats: certified to teach multiple subjects or grade levels, prepared to supervise several extracurricular activities, and able to teach students of differing ability levels within a single classroom. The PD-STEP Model helped teachers develop the skills necessary for integrating FANH concepts in their classes, explore the opportunities available in the FANH career paths, and forge mentorships with professional and business leaders and Texas A&M International University faculty. Teachers participating in the PD-STEP Professional Development sessions completed pre- and post-surveys (see Appendices A and B). We analyze these data in the following section.

### **Data Analysis**

The participants’ survey responses were analyzed for recurring themes and educational gaps highlighted by the teachers. First, the pre- and post-participation surveys were read by all three of us individually (Bogdan & Biklen, 2007). Then we scheduled a follow-up session to discuss the findings and compare and contrast the participants’ perceptions with our observations during the professional development sessions. Since the surveys included data to be compiled by tally and frequency, we documented these in journals and

notes taken from our individual reading of the teachers' surveys and from our recurrent discussions. Then we created a coding system (Charmaz, 2006). In addition, some of the data that were more qualitative in nature, such as participants' interviews and observation data, were transcribed and analyzed for recurrent themes. We organized the data into patterns and themes (Merriam, 1998). Subsequently, the themes that we identified were (a) knowledge and skills, (b) students' academic needs, (c) field-based experiences, (d) post-professional development survey questions, and (e) effective professional development experiences. Overwhelmingly, the teachers's pre- and post-professional development surveys validated that they were self-motivated to participate in PD-STEP Professional Development sessions.

### Knowledge and Skills

Teachers responded to the pre-professional development questions related to knowledge and skills, which we identified as Questions 3 and 5. The following are some examples: How many years of teaching experience do you have? What subject areas have you taught? What grades have you taught? (See Table 3). The rural teachers' expertise was strong, and this positive situation was also a call for action by district officials who needed to find and train novice teachers to fill the vacancies left by teachers who retired. In response to the following question: Please add any additional comments related to your experience in today's PD-STEM Teachers Professional Development (see Table 4). Participating teachers' dispositions to network with rural school teachers from nearby rural school districts were positive and strong.

**Table 3**

*Responses Concerning Experience*

Participant	Experience
Teacher 1	I have five years of teaching experience in subject areas of Principles of Agriculture, Advanced Animal Science, Equine Science, Livestock Production, Wildlife, and small animal management. All subjects include ninth through twelfth grade students.
Teacher 5	I have taught Grade 9 through 12 sciences for 24 years. I have taught Biology, Chemistry, Physics, IPC, Anatomy, & Physiology, Astronomy, Environmental Systems, and Medical Terminology.
Teacher 9	I have 31 years of teaching high school math and I am always looking for motivational experiences for my students.
Teacher 10	I have 18 years of experience teaching science, English, mathematics in both fifth grade and eighth grade.
Teacher 14	I have been teaching for 27 years—all at the high school level. I have taught Biology, but I am an Agricultural Science teacher now.
Teacher 15	I have been teaching for 22 years and presently teach Culinary Arts and Child Development for ninth through twelfth graders.

**Table 4***Additional Comments*

<b>Participant</b>	<b>Comments</b>
Teacher 1	I hope to gain more knowledge and personal growth from this program.
Teacher 9	I am very excited to be here and learn new things that I can apply in my classroom.
Teacher 10	I am very motivated to be here and learn new ideas for my classroom.
Teacher 12	I am extremely excited for what this week has to offer and taking this journey with this team for the next year!
Teacher 14	I hope to network with all the other teachers and have a positive experience.
Teacher 15	I hope this experience will open many more windows of opportunity to engage students in learning where food comes from.

**Table 5***Expectations of Learning from Professional Development*

<b>Participant</b>	<b>Expectations of Learning</b>
Teacher 1	To expect the unexpected. I hope to learn different aspects of this professional development to incorporate properly in the classroom and lessons.
Teacher 2	To be able to use mathematics into the STEM field and be able to get students involved in this program.
Teacher 5	To be able to use science lessons to teach everyday applications in the agricultural field.
Teacher 7	To be able to understand the nature of horticulture in this South Texas environment.
Teacher 9	I hope to learn more hands on activities that I can use in my classroom that relate to the environment.
Teacher 10	How to better prepare for my students' learning needs.
Teacher 11	I expect to learn how to incorporate gardening into my curriculum—helping to teach students life-skills.
Teacher 12	I hope to learn something new and different I can take back to my classroom to provide my kids with a hands-on experience.
Teacher 13	How to incorporate STEM into my daily lessons to keep the students engaged.
Teacher 14	I expect to be able to better serve our students by integrating/aligning mathematics and science to our agricultural science curriculum. I also expect to develop better lesson plans and teaching strategies to engage students.
Teacher 15	I expect to acquire knowledge in various agricultural aspects as they apply to the food chain.



**Students’ Academic Needs**

We identified Question 1 of the pre-professional development survey as addressing the students’ academic needs component: Can you please tell us what you expect to learn from this professional development experience? (See Table 5). PD-STEP participants’ high levels of self-motivation increased our motivation to plan and execute an engaging professional development workshop. In fact, several studies have suggested that the efficacy of rural school teachers is related to job satisfaction and a positive school context in which professional ideas are shared and mutual trust thrives (Edinger & Edinger, 2018; Lacks & Watson, 2018). We focused

on creating the professional network space for the participants to share and build professional relationships outside of their school districts.

**Field-Based Experiences**

We identified Question 2 from the pre-professional development survey as pertaining to the teacher participants’ field-based experiences: Can you please explain your motivation to be part of this professional development experience? (See Table 6). Hadré (2008, 2011) explained that “what teachers do influences students’ motivation and choices, and what students do influences teachers’ motivation and practice” (2011, p. 214), especially in a rural school setting.

**Table 6**

*Motivation to be Part of this Professional Development Experience*

<b>Participant</b>	<b>Motivation to Participate</b>
Teacher 5	To help provide innovative field-based methods of instruction to fellow teachers and to learn to collaborate between STEM teachers and CATE* teachers.
Teacher 7	My degree in agriculture science gives me a natural development in this field and I would like to continue my development for this field in the form of student-centered lessons.
Teacher 9	The department chair at my school wants to grow a garden in the high school for our students to use. This would be a great experience for me to obtain the information and apply it.
Teacher 11	I teach biology, and I had my students grow plants this year just to expose them to the growing process. I wanted them to see seeds and watch them grow. However, I do not have any curriculum for this experience so this class is just what I needed.
Teacher 12	The opportunity to implement something new and unique in the classroom motivated me to be part of this professional development experience. I have also always wanted to begin a garden at school.
Teacher 14	Again, to be able to have more meaningful lessons and engage students so they can experience success and want to back to my class.
Teacher 15	My motivation is to become knowledgeable in different agricultural topics related to the food industry, i.e., food crops.

\* CATE is an abbreviation for career and technical education.

### Post-Professional Development Survey Questions

We grouped the post-professional development survey questions and the respective teacher participants' responses into three categories: effective professional development experiences, suggested activities, and instructional strategies and goals met.

### Effective Professional Development Experiences

Were the activities/approaches used to facilitate the professional development experience effective? We asked participants to elaborate on the activities that they enjoyed the most and that they thought would be useful in their teaching (see Table 7). Participants enjoyed sharing their classroom experiences with rural school peers who could relate to the demographics, context, and challenges that rural school teachers face. We concluded that hands-on lessons were successful in motivating our rural school teachers' interest in incorporating the sample PD-STEP lessons.

**Table 7**  
*Activities Related to Teaching*

Participant	Activities
Teacher 1	I believe that all the activities were helpful. I enjoyed the pattern lesson and the master gardening lessons to further enhance our class participation. Most of the lessons were mainly to the average student, GT; one modification would be to consider the special education students and how to involve them in the lessons we want to cover.
Teacher 2	The hands-on activities were the ones I enjoyed the most. In addition, going outside and enjoying nature was educational but relaxing. The short videos from Texas Wildlife Association (TWA) were also beneficial and will help students.
Teacher 4	I enjoyed the observations with Leopold. This will be very useful in the class because it make the students become more aware of nature and develop a sense of preservation.
Teacher 5	The sample lessons that were provided were useful to me as a science teacher. I will be able to incorporate this type of teaching and lesson planning this year. I will modify with different videos.
Teacher 6	Outdoor activities are always good because it provides a change for students. Community involvement will be important and can help to create unity.
Teacher 10	All the hand-on activities provided good opportunities for student engagement. I would like to see lesson plans developed using release STAAR questions content to make it more relevant to high school.
Teacher 11	Hands-on lessons were awesome. Limit the stand and deliver approach.
Teacher 12	Yes! All of the hands-on activities were very fun and engaging. I could see myself doing similar approaches.
Teacher 13	All activities were awesome! All were fun and interactive. Great job!
Teacher 14	All activities were great. Working hands-on labs @ LBV Bldg. was the best way to engage our learning.

### Suggested Activities

We asked, “If you were to do this again, what additional activities and/or approaches would you suggest?” (See Table 8). Based on the participants’ comments, we believe that our face-to-face professional development sessions for the participants were successful in addressing teacher self-efficacy and teacher well-being—which we hope will lead to reducing rural school teacher attrition.

We asked, “What suggestions do you have for improving this professional development experience?” (See Table 9). Since this was the first of a series of a three-year summer professional development opportunities for rural school teachers, their feedback was important for the planning of subsequent professional development activities. Therefore, the participants’ feedback was well-received and incorporated in the second year’s professional development sessions.

**Table 8**

*Additional Activities and/or Approaches*

Participant	Additional Activities
Teacher 1	I believe more of the technological basics and design. Our schools are wanting us to use computers and i-Pads to teach our students.
Teacher 2	Again, just being in the outdoors and getting your hands dirty are the best ways to run these professional developments.
Teacher 3	Additional cooking demonstrations with non-common vegetables.
Teacher 4	I am open to whatever else can be added to enhance the learning experience relating to understanding Texas wildlife.
Teacher 9	Secondary high school teachers need high school activities. Model high school activities in real world time constraints.
Teacher 12	I would try to apply different sciences (chemistry) to the lesson plans and present them at a higher level.
Teacher 13	I would just keep doing what you are doing. We have been to this professional development before and did not feel like it repeated. I also learned many new things.

**Table 9**

*Suggestions for Improving the Professional Development Experience*

Participant	Suggestions
Teacher 2	We covered a lot of information, we have to go back and digest all the info. So maybe condense the information but surely keep the hands-on activities.
Teacher 3	All aspects were wonderful. No improvement needed.
Teacher 4	It was a wonderful learning experience.
Teacher 10	Continue to work with local teachers to design lesson plans around TEKS-related activities.
Teacher 12	It was very fun and interesting. I really enjoyed all the activities.
Teacher 14	Keep the same group of people for year 2! It was an awesome experience! Looking forward to meeting again.

**Instructional Strategies Learned and Goals Met**

We asked, “To what extent do you feel the goals/objectives of PD-STEP were accomplished? Please explain.” (See Table 10). We asked this question to gain insight into the extent to which the PD-STEP goal of integrating field-based experiences, situated learning (Korthagen, 2010), experiential methods (Steffe et al., 2000), and problem-based learning (Savery & Duffy, 1995) into lessons was achieved.

We asked, “What do you feel you have gotten out of your recent professional development experiences? How have they influenced your teaching practices?” (See Table 11). We believe that all teachers learn more effectively from hands-on professional development opportunities; and this group of 15 participants agreed that the interactive lessons were pertinent to their teaching assignments in rural schools.

**Table 10***Goals/Objectives of PD-STEP*

<b>Participant</b>	<b>Accomplishment of goals and objectives</b>
Teacher 1	They were mostly accomplished by involving all aspects of mathematics, science, engineering in agriculture.
Teacher 2	I felt the goals were accomplished, sometimes a bit rushed but there was just so much information to cover.
Teacher 3	I learned a great deal about the need for food in given areas and the lack of knowledge many of our students possess.
Teacher 4	All the goals/objectives were accomplished. The delivery of the lessons/activities were well constructed and flowed very efficiently, and they were fun and educational.
Teacher 5	I feel the goals were accomplished and received a lot of useful information and resources.
Teacher 6	PD-STEP provided the resources to create a community garden. We will also be able to get answers through the Agriculture Extension Office.
Teacher 8	By actually showing the garden – tied in with mathematics, health, science tied it all together.
Teacher 10	They were accomplished to some degree. I realize it is the 1 <sup>st</sup> year of the program but we will need to work harder to connect topics in TEKS to the lesson plans presented

**Table 11***Influence of Recent Professional Development on Teaching Practices*

<b>Participant</b>	<b>Benefits gained from this program</b>
<b>Teacher 1</b>	More hands-on activities which will help develop better or more interactive lessons. I have a new approach and point of view.
<b>Teacher 2</b>	Yes, the hands-on activities influenced my teaching practice and I have actually learned a lot and will take these to my students. It was a refresher in a sense.
<b>Teacher 3</b>	Learned a great deal. I will incorporate more hands-on activities in my lessons and relate them cross curricular.
<b>Teacher 4</b>	A revelation to nature and wildlife. It will enhance my teaching practice by placing more emphasis on the preservation of our land.
<b>Teacher 6</b>	Recently, I have been attending more PD that emphasize constructivist learning. Emphasis is placed on kids doing activities and building knowledge through activities.
<b>Teacher 7</b>	I improved my science and math skills in master gardening.
<b>Teacher 9</b>	A fresh perspective for redesign lessons which has disciplines with real-world applications.
<b>Teacher 10</b>	I am learning with so many more resources and lots of knowledge about gardening and how it relates to environmental science.
<b>Teacher 11</b>	I'm inspired to complement my new knowledge, continue implementing hands-on lessons to inspire and reach my students.
<b>Teacher 12</b>	I feel very informed in the agricultural area. I'm able to see connections and how they can be implemented to math and science.
<b>Teacher 13</b>	I learned a lot more about land stewardship and have new, fresh ideas for the school year.

We asked, "What new strategies learned during the PD-STEP professional development experience have you tried lately that might benefit a student you are struggling with?" (See Table 12). We were pleased to read the participants' feedback because the rural school teachers' message was clear: They enjoyed the activities and were enthusiastic about trying the PD-STEP lessons in their classrooms.

#### **Lessons Learned from First-Year Experience**

Rural school districts have a shortage of specialized teachers and are challenged in finding mathematics, and science teachers (Levin et al., 2011). This challenge has serious consequences for rural students by limiting their access to courses

that will get them college-ready such as calculus, physics, trigonometry (Johnson & Zoellner, 2016). Rural school districts prefer to hire teachers who are certified in multiple areas of science, mathematics, or social sciences or grow their own homegrown multidisciplinary teachers (Johnson & Zoellner, 2016). We believe that the agricultural mathematics, science, and technology skills field-based experiences that we designed helped develop rural school teachers' multidisciplinary knowledge and skills. Consequently, the goals of PD-STEP were to develop and provide a cadre of mathematics,

**Table 12***New Strategies Learned during the PD-STEP Professional Development Experience*

Participant	New strategies learned
Teacher 2	Short videos and hands-on activities will be my focus this year. Takes more planning and collection of activities/materials but will give you a better result.
Teacher 3	Planting a garden will give my students ownership and teach them how to care form something.
Teacher 4	Include more activities to spark interest in a topic or area of study for the students to learn about.
Teacher 6	I have tried utilizing activities to teach concepts to students who are struggling. I have given troubled students projects and extra responsibilities to try to bring ownership to their learning.
Teacher 8	The bottle effect of sand, silt, clay will help student envision how soil profiles work.
Teacher 9	Research and create applications to use in areas which are real world and connected to agriculture.
Teacher 12	There were different lessons that had different approaches to the topic, so it really varies. The different approaches were very helpful and I will try to implement them in my lessons.

science, CATE rural high school teacher teams (STEM Field Teams) from five rural districts in Texas with hands-on experiences and real world applications of the STEM fields during a week-long faculty development opportunity. The first year of PD-STEP, the STEM Field team focused on (a) recruiting teachers and establishing strategies for research-based instructional lessons aligned to agricultural mathematics, science, and technology knowledge and skills and (b) catering to the specific needs of English language learners by focusing on indigenous, authentic agricultural topics addressed through field-based experiences.

During the first year, we conducted on-site visits to each of the five participating school districts to recruit 15 teachers and conducted a four-day faculty development that included hands-on activities and the presentation of the PD-STEP lesson plan model to the teachers. This professional development opportunity provided rural school teachers from five South Texas school districts with the necessary tools to expand their multidisciplinary backgrounds and supported their development as the multidisciplinary instructional leaders that the school

districts required. The teachers' perceptions of their first-year experience informed programmatic improvements associated with lesson planning and delivery. Each of the three years of the grant will build on the experiences of the professional development activities from the previous year. As a result of conversations with rural school districts and the external grant evaluator, we decided to extend the invitation to participate to the same teachers in order to build their professional skills and strengthen their rural school teachers' network.

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## Appendix A

### PD-STEP into the STEM Field

#### STEM Teachers Pre-Professional Development Survey

The goal of the STEM Field project is to develop and provide, to a cadre of mathematics, science, and career and technical education (CATE) rural high school teacher teams (STEM Field Teams), an innovative agricultural-based face-to-face and hybrid professional development. The Project Team is interested in capturing the participants' feedback to help them align and/or modify the STEM Field Model professional development activities. The Project Team will be utilizing research-based instructional strategies aligned to Texas Essential Knowledge and Skills (TEKS) curriculum standards that are purposefully centered on (1) agricultural mathematics, science, and technology knowledge and skills; (2) specific needs of English language learners; and (3) indigenous, authentic agricultural topics through field-based experiences first.

1. Please tell us what you expect to learn from this professional development experience.
2. Please explain your motivation to be part of this professional development experience.
3. How many years of teaching experience do you have? Which subject areas have you taught? What grades have you taught?
4. Have you recently been assigned to a different grade level? If yes, please let us know how this professional development experience can help you prepare for your new teaching assignment.
5. Please add any additional comments related to your experience in today's PD-STEM Teachers Professional Development.

**Appendix B****PD-STEP into the STEM Field****STEM Teachers Post-Professional Development Survey & Reflections**

The goal of the STEM Field project is to develop and provide, to a cadre of mathematics, science, and career and technical education (CATE) rural high school teacher teams (STEM Field Teams), an innovative agricultural-based face-to-face and hybrid professional development. The Project Team is interested in capturing the participants' feedback to help them align and/or modify the STEM Field Model professional development activities. The Project Team will be utilizing research-based instructional strategies aligned to Texas Essential Knowledge and Skills (TEKS) curriculum standards that are purposefully centered on (1) agricultural mathematics, science, and technology knowledge and skills; (2) specific needs of English language learners; and (3) indigenous, authentic agricultural topics through field-based experiences first.

1. Were the activities/approaches used to facilitate the professional development experience effective? Please elaborate on the activities that you enjoyed the most and will be useful in your teaching. Please elaborate on what needs to be modified or improved.
2. To what extent do you feel the goals/objectives of PD-STEP were accomplished? Please explain.
3. If you were to do this program again, what additional activities and/or approaches would you suggest?
4. What do you feel you have gotten out of your recent professional development experiences? How have they influenced your teaching practice?
5. What suggestions do you have for improving this professional development experience?
6. What new strategies learned during the PD-STEP professional development experience have I tried lately that might benefit a student I am struggling with?